# A COMMUNAL ROOST OF BUTTERFLY *HELICONIUS CHARITONIUS* L. IN COSTA RICAN PREMONTANE TROPICAL WET FOREST (LEPIDOPTERA: NYMPHALIDAE)[1]

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ABSTRACT: The communal roosting behavior of the Neotropical butterfly *Heliconius charitonius* L. (Nymphalidae: Heliconiinae) was studied briefly at one locality in the wet forest region of northeastern Costa Rica. By marking individual butterflies, it was discovered that females returned less frequently than males, resulting in a 1:3 sex ratio of roosting butterflies. Freshly-eclosed males were also seen on the roost. Individuals of both sexes were inconsistent in appearing at the roost over several days, perhaps a result of phenotypic differences. Considerable recruitment of freshly-eclosed butterflies occurred, while marked butterflies declined in frequency.

Communal roosting has been observed for several species of *Heliconius* butterflies (Nymphalidae: Heliconiinae) in sub-tropical and tropical regions of America (Jones 1930; Poulton 1931; Benson 1971; Turner 1971, 1975; Young and Thomason 1975; Young and Carolan 1976). The adaptive significance of this gregarious behavior in adult *Heliconius* has been discussed (Benson 1972; Gilbert 1975; Turner 1975). Gilbert (1975) suggests that communal roosting in these butterflies evolved as the result of young, inexperienced individuals following and roosting near experienced individuals to improve their ability to find scarce or inconspicuous pollen sources, as pollen feeding is of major importance to the reproductive success of many *Heliconius* (Gilbert 1972). While it may be true that individuals are faithful to a roosting site over a long period of time in some species of *Heliconius* (Benson 1971, 1972), *H. charitonius* Linn. (*H. charitonia*) in montane tropical wet forest of Costa Rica exhibits considerable short-term (daily) variation in roost fidelity (Young and Carolan 1976). The present paper concerns the description of the short-term turnover in roost membership for *H. charitonius* at a Premontane Tropical Wet Forest locality in northeastern Costa Rica.

## METHODS

The study area is "Finca La Tigre" near La Virgen de Sarapiqui (220 meters elev.), Heredia Province, in northeastern Costa Rica. This site is

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adjacent to "Finca La Tirimbina" and about two kilometers from a previous study of *H. charitonius* (Young 1976). Both sites are in the Premontane Tropical Wet Forest life zone (Holdridge 1967). On the late afternoon of January 18, 1977 a communal roost of *H. charitonius* was discovered on a fallen tree in secondary growth along a dirt road. Using the technique of studies of *H. charitonius* (Young and Thomason 1975; Young and Carolan 1976; Cook et al. 1976), the butterflies were marked at dawn on February 7, 1977, recording the sex and "age" ("young", "middle", "old") of each individual. Unlike previous studies, the butterflies were marked only on one date. The roost was observed from February 7 to February 27, 1977, during an erratic dry season. For a total of ten evenings (census dates), the roost was visited at 7:00 P.M. and the number of marked and unmarked butterflies recorded, along with a separate tally of freshly-eclosed individuals (new recruits). Although "young" *Heliconius* butterflies have been defined as one month old (Gilbert 1975), in this paper I equate "young" with freshly-eclosed individuals. Daily weather data (rainfall, temperature) were available from "Finca La Tirimbina". Data were also kept on the number of "sub-roosts", as sometimes the roost membership was split into separate groups.

## RESULTS

A total of 37 butterflies were marked at the roost on the morning of February 7, and four or five individuals were missed; of the 37 marked, eight were females and 29 were males, a greater than 1:3 sex ratio. About one-third of the butterflies (11) were young or freshly-eclosed, and only seven were old (tattered, worn) individuals, suggesting a roost membership of predominantly middle-age butterflies, probably 1-4 months old (based on Gilbert 1975; Cook et al. 1976), and two or more generations. This contention is also supported by the fact that this roost existed for at least 5 weeks by the end of the study.

The census history of marked butterflies is summarized in Table 1 which, by inspection, shows that individual faithfulness to the roost is highly variable for the short observation period of 20 days. While marked butterflies return to the roost on different dates (Fig. 1), some individuals appear more times than others: two young males (nos. 34, 36), one old female (no. 35), and two middle females (nos. 15, 29) returned eight out of ten evenings. After the first census date, several individuals were never seen again, including young and middle females, and middle and old males (nos. 2, 5, 14, 18, 20, 25, 31 – Table 1). Although the total number of resightings was about the same (16-20) for census dates in the period February 7-16 (see last row in Table 1), there was a noticeable drop in resightings (9-13) following this time (Table 1). The decline in roost membership, including unmarked individuals, occurred

at a time of irregular daily rainfall (Fig. 2). For the period February 7-9, the mean maximum temperature (12:00 noon) was 28.5°C and the mean minimum (6:00 P.M.) was 20.0°C; for the period February 14-27, these values were 32.0°C and 19.0°C respectively. There appears to be little or no correlation of roost activity and weather for the observation period.

While few data are available for females (owing to the small sample size), the frequency of resightings for young, middle, and old males was very

Fig. 1. The communal roost of *H. charitonius* showing both marked and unmarked butterflies, February 15, 1977, 6:30 A.M.

similar (Table 2). It is interesting to note that the highest number of resightings for an individual male butterfly, eight, was seen for an old individual as well as two young ones (Table 2).

Although the number of marked butterflies declined later, both the overall frequency of unmarked ones and young ones increased (Table 3). Most of the unmarked butterflies seen after February 9 were freshly-eclosed (Table 3), indicating a recruitment of new adults. Old butterflies were resighted several times: excluding resight data taken on the first census date, 75% of all butterflies marked were resighted at least once during the study period, and there were no instances of an old individual not being resighted at least once. In fact, of the seven old individuals marked, four were resighted several times each during the study period (Table 1).

The daily formation of the roost involved several butterflies settling on the low vegetation beneath the tree, usually within an hour of sunset, and just before dark, they flew up and settled on the branches. Departure from the roost in the morning was very sudden. Inspection of roosting butterflies revealed great variation in pollen load size: whitish pollen loads were very large and crusty on some individuals, smaller on others, and absent on others.

## DISCUSSION

*Heliconius charitonius* is an advanced species of the genus, occurring in a wide variety of habitats, including those created by man (Brown 1972). At "Finca La Tigre" it thrives in a broad spectrum of secondary habitats, and the communal roost studied was found in a recently cut area. Benson (1972) showed that *H. erato* in southwestern Costa Rica has communal roosts characterized by high individual faithfulness over long periods (several months). Although individuals of *H. charitonius* are faithful to roosts over similar periods in montane tropical wet forest in Costa Rica (Young and Thomason 1975), presumably a result of a cohesive population structure (Cook et al. 1976), there is considerable daily variation in individual faithfulness (Young and Carolan 1976). The present data show that individual faithfulness to a communal roost is variable in premontane tropical wet forest. An interesting difference between the previously studied Costa Rican roosts and the present one is the strong bias for males in the latter; the other roosts had about 1:1 sex ratios (Young and Thomason 1975 ;Young and Carolan 1976). As a communal roost is likely to have individuals from more than one generation (Gilbert 1975), it is expected that the frequency of young (reproductive) females on a roost will vary through time as related to their foraging and oviposition activity. The scarcity of females on a roost could be the result of freshly-eclosed (young) females dispersing in search of oviposition sites, very soon after eclosion. Freshly-eclosed females are mated very soon after

**Table 1. The census history of *Heliconius charitonius* butterflies experimentally marked (7 February) at a communal roost at Finca La Tigre, near La Virgen de Sarapiqui, Costa Rica, 1977.***

| Individual No. | Sex | Age** | Feb 7 | Feb 8 | Feb 9 | Feb 14 | Feb 15 | Feb 16 | Feb 19 | Feb 20 | Feb 21 | Feb 27 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | M | O | X*** | | | | X | X | | | | |
| 2 | M | O | | | | | | | | | | |
| 3 | M | Y | X | X | X | | | | | | | |
| 4 | M | M | X | X | X | | | | | | | |
| 5 | F | Y | | | | | | | | | | |
| 6 | M | M | X | | X | | | | | X | X | X |
| 7 | M | M | X | | X | X | X | X | X | | | X |
| 8 | M | M | X | | | | | | | | | |
| 9 | M | M | X | X | X | X | X | X | X | | X | |
| 10 | M | Y | | X | X | X | X | X | X | | | |
| 11 | M | M | X | X | X | X | X | X | | | | |
| 12 | M | M | | | | X | X | X | | X | X | X |
| 13 | M | Y | X | | X | | | | | | | |
| 14 | M | M | | | | | | | | | | |
| 15 | F | M | X | | X | X | X | X | X | X | X | |
| 16 | M | Y | X | X | X | X | X | X | | | | X |
| 17 | M | O | | | X | | | | | | | |
| 18 | M | O | | | | | | | | | | |
| 19 | M | O | X | X | X | X | X | X | X | X | | X |
| 20 | F | M | | | | | | | | | | |
| 21 | M | O | X | | X | X | X | X | X | | X | X |
| 22 | M | M | | | | X | X | X | X | | | |
| 23 | F | M | | | X | X | X | X | X | X | X | |
| 24 | M | M | | X | | | | | | | | |
| 25 | F | Y | | | | | | | | | | |
| 26 | M | M | X | X | | | | | X | | X | |
| 27 | M | M | | X | X | | | | | | | |
| 28 | M | Y | | X | | | | | | | | |
| 29 | F | M | X | X | | X | X | X | X | X | X | X |
| 30 | M | M | X | X | | | | X | | | | |
| 31 | F | M | | | | | | | | | | |
| 32 | M | Y | X | X | X | X | | | | | | |
| 33 | M | Y | X | | | | | | | | | |
| 34 | M | Y | X | | X | X | X | X | X | X | X | X |
| 35 | F | O | X | X | X | X | X | X | X | X | X | X |
| 36 | M | Y | | X | X | X | X | X | X | X | | X |
| 37 | M | Y | | X | X | | | | | | | |
| TOTAL DAILY RESIGHTINGS | | | 20 | 17 | 20 | 16 | 16 | 17 | 13 | 9 | 10 | 10 |

*Some butterflies, i.e. entries, 2, 5, 14, 18, 20, 25, and 31 were not resighted at all following the marking, and no resightings are available for them.

**O = old; M = middle age; Y = young

***="X" means this individual was seen on the roost that evening

eclosion (Edwards 1881). A larval food plant of *H. charitonius* at the study area, *Tetrastylis lobata* (Young 1976), is widely dispersed as small patches, perhaps promoting a rapid dispersal of newly mated females and thus lowering their frequency at a communal roost over short periods. Females of *H. charitonius* can be faithful to a roost over a long period (Young and

**Table 2. Number of resightings of marked butterflies seen at least twice (excluding first census on Feb. 7) at roost.**

| Age class: | Young | Middle | Old |
|---|---|---|---|
| Females | | | |
| N* | 0 | 3 | 1 |
| Resight freq. | – | 7, 7, 8 | 9 |
| X ± S.D. | – | 7.31 ± 0.57 | – |
| Males | | | |
| N* | 6 | 9 | 3 |
| Resight freq. | 2, 6, 6, 3, 8, 8 | 2, 4, 6, 7, 5, 6 4, 3, 2 | 2, 8, 7 |
| X ± S.D. | 5.50 ± 2.50 | 4.33 ± 1.80 | 5.66 ± 3.21 |
| Total | | | |
| N* | 6 | 12 | 4 |
| X ± S.D. | 5.50 ± 2.50 | 5.08 ± 2.06 | 6.50 ± 3.10 |

N = number of different individuals resighted

**Table 3. Frequency of unmarked butterflies, including freshly-eclosed individuals, at the roost.**

| Date | No. unmarked | Portion of these freshly-eclosed | No. marked butterflies | % unmarked |
|---|---|---|---|---|
| Feb 8 | 5 | 2 | 17 | 23% |
| 9 | 7 | 3 | 20 | 26% |
| 14 | 5 | 4 | 16 | 24% |
| 15 | 8 | 5 | 15 | 34% |
| 16 | 10 | 7 | 17 | 37% |
| 19 | 13 | 8 | 13 | 50% |
| 20 | 12 | 6 | 9 | 57% |
| 21 | 14 | 7 | 10 | 58% |
| 27 | 11 | 8 | 10 | 52% |

Thomason 1975) and they exhibit home range movements (Cook et al. 1976). Furthermore, over long periods, it is expected that both males and females of advanced *Heliconius* species will exhibit high roost faithfulness and home range movements for location and exploitation of adult food sources (Gilbert 1975). Over short periods, however, various environmental and phenotypic factors may lead to individual differences in roost faithful-

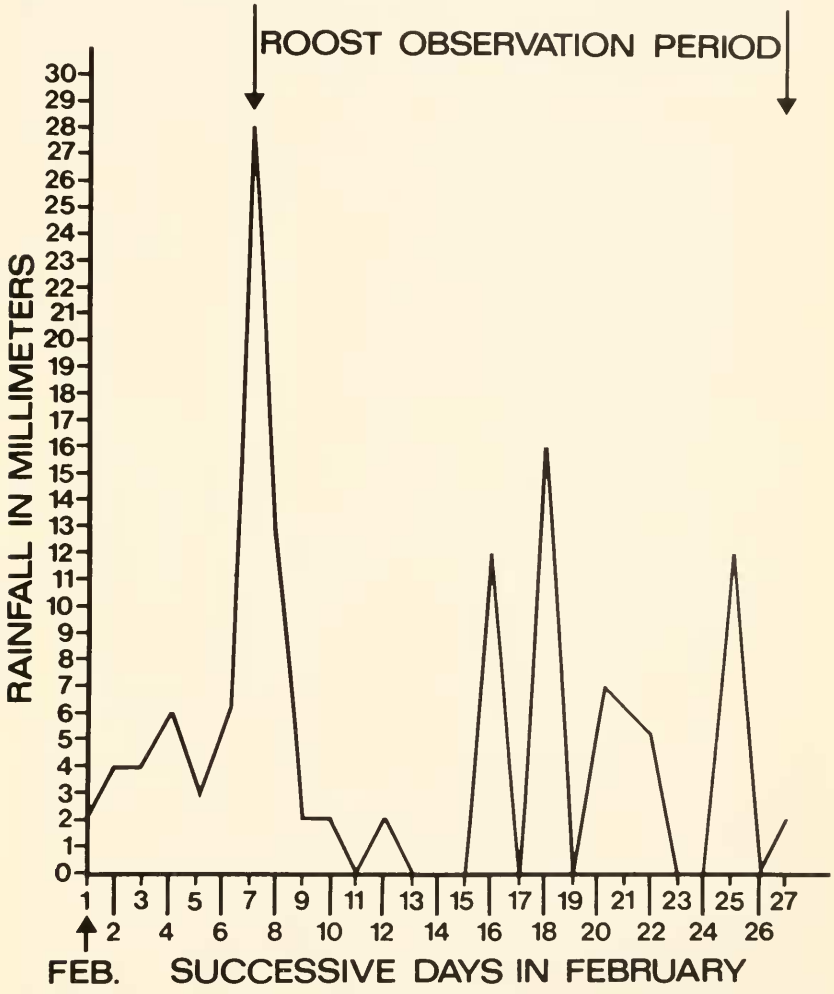


Fig. 2. Daily rainfall (in mm) at Finca La Tirimbina; data courtesy of Dr. J. Robert Hunter. Communal roosting was observed for both wet and dry days.

ness. As a long term form of adaptive behavior, communal roosting increases recruitment of new individuals to the group and perhaps increases breeding success (Brown 1970).

Short term variation in roost faithfulness may be due to several factors such as phenotypic differences in mobility, location of adult food sources and oviposition sites, and weather. Older butterflies may exhibit high roost faithfulness as a result of becoming very familiar with the surrounding habitat. Gilbert (1975) emphasizes that *Heliconius* use land marks in daily movements and older butterflies are more experienced at doing this. The data show that old butterflies were very faithful to the roost. The data also support the hypothesis of Gilbert (1975) that young butterflies roost with older ones as a means of becoming more familiar with the habitat: there was a steady recruitment of young adults throughout the study period.

The data indicate that some butterflies of both sexes show up regularly at a roost. Following the reasoning of Gilbert (1975) selection should favor high residentiality in *Heliconius* as a means of allowing butterflies to be efficient foragers of patchy resources. In addition to a larval food plant, *Tetrastylis lobata* (Passifloraceae) (Benson et al. 1976; Young 1976), adult food plants such as *Cissus biformifolia* (Vitaceae), *Anguria warcewiczii*, and *Gurania costaricensis* (both Curcubitaceae) are very patchy over large areas of secondary growth that surround the roost site.

Brown (1972) considers advanced species of *Heliconius* to possess flexible behavior. An example of such flexibility in *H. charitonius* might be the changing of roost sites in a habitat. Whether or not optimal roosting sites are limiting factors has not been determined. Young and Thomason (1975) suggested that absences of marked butterflies from a communal roost of *H. charitonius* could be due to individuals using different roosts on different days. Multiple roosts of *H. charitonius* in a small area have been found (Jones 1930). In the present study, such a factor could have contributed to some of the daily turnover in roost membership, although this effect is small since resightings were high for several individuals. Prolonged absences from a communal roost or a sudden decline in roost membership is likely not related to local weather conditions.

Turner (1975) suggested that communal roosting in *Heliconius* evolved as a mechanism to ensure home range movements, rather than as the result of these butterflies being unpalatable to predators. The palatability of *H. charitonius* is undetermined. Under Turner's model, communal roosting is viewed as an opportunistic, flexible behavior subject to modification as factors affecting home range movements change. Thus, the observed short-term turnover in roost membership of *H. charitonius* in the present study is supportive of Turner's model. Perhaps under the alternative explanation of unpalatability, roost faithfulness over short periods would be higher in order

to ensure the operation of collective behavior associated with educating naive predators.

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